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EXAMINER

BHAT, NARAYAN KAMESHWAR

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/511,841	Applicant(s) LEE ET AL.	
	Examiner NARAYAN K. BHAT	Art Unit 1634	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 02 May 2008.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-14 is/are pending in the application.
- 4a) Of the above claim(s) 14 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-13 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

FINAL ACTION

1. This office action is written in reply to applicant's correspondence filed May 2, 2008. Claims 1 and 13 were amended. Applicant's amendments requiring "if metal ion is permitted to enter the duplex a metal containing base pair is formed and if a metal ion is excluded from the duplex a non-metal containing base pair is formed" necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.**

2. Claims 1-14 are pending in this application and claims 1-13 are under prosecution.

Claim Objections

3. Objections to claim 1 in the previous office action have been withdrawn in view of claim amendments.

Amendments to Claims

4. Amendments to the claims 1 and 13 have been reviewed and entered.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. Claims 1-3 and 5-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Branton et al (USPN 6,627,067 filed Jun. 22, 2000) in view of Aich et al (WO 99/31115, published June 24, 1999).

Regarding claim 1, Branton et al teaches a process of recording sequence information in a nucleic acid polymer, comprising modulating the translocation of the first poly dA nucleic strand and the second poly dT nucleic acid strands through a channel between two medium by applying voltage gradient across the channel (column 20, lines 37-41). Voltage gradient is one of the preferred methods to translocate nucleic acid as defined in the instant specification (instant specification, USPGPUB, paragraph 0037). Branton et al also teaches that the medium in the channel is conducive for the formation of hybridized double stranded poly dA-poly dT with a voltage gradient of 160 mV (column 20, lines 20-21), thus teaching that the medium in the channel is the hybridization medium. Branton et al also teaches that the medium above the channel

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comprises poly dA strand and poly dT strand without forming the double stranded DNA at a lower voltage gradient (column 20, lines 57-58), thus teaching medium above the channel is the dissociation medium.

Branton et al also teaches applying voltage gradient across the channel to modulate the formation of duplex in the hybridization medium (column 20, lines 40-41), thus teaching modulating an electrostatic potential across the channel to form a nucleic acid duplex in the channel. Branton et al are silent about incorporation of metal ions into nucleic acid duplex so that metal ion is permitted to enter the duplex a metal containing base pair is formed and if a metal ion is excluded from the duplex a non-metal containing base pair is formed.

Branton et al also teaches that the channel separating the hybridization medium and the dissociation medium is dimensioned to allow linear translocation of the nucleic acid duplex (column 20, lines 41-43, step 'b' of the claim). Branton et al also teaches that the single stranded poly dA oligonucleotides hybridizes to complementary poly dT oligonucleotides to form a duplex (column 20, line 40), thus teaching first and the second nucleic acid strands comprise a plurality of nitrogen-containing aromatic adenosine purine bases covalently linked by a backbone, the nitrogen-containing aromatic bases of the first nucleic acid strand being capable of being joined by hydrogen bonding in the hybridization medium to the nitrogen-containing aromatic thymine bases of the second nucleic acid strand so that the nitrogen-containing aromatic bases on the first and the second nucleic acid strands form hydrogen-bonded base pairs in stacked arrangement in the nucleic acid duplex.

Branton et al are silent about hydrogen-bonded base pairs being capable of interchelating the metal cation coordinated to a nitrogen atom in one of the aromatic nitrogen-containing aromatic bases to form the metal-containing nucleic acid duplex.

Regarding claim 2, Branton et al teaches the step of reading sequence information from the nucleic acid polymer (column 17, lines 15-18).

Regarding claim 3, Branton et al teaches the detection of presence or absence of nucleic acids by measuring the electrical conductance across the channel as the nucleic acid duplex is translocated through the channel between the hybridization medium and the dissociation medium (Fig. 12B, # 84, column 20, lines 43-47). Branton et al are silent about detecting the presence or absence of the metal cations as the nucleic acid duplex is translocated through the channel.

Regarding claim 5, Branton et al teaches that the channel is formed in a lipid membrane (Fig. 1, and column 6, lines 62-64).

Regarding claim 6, Branton et al teaches that the channel is a pore forming alpha hemolysin protein (Fig. 2, and column 20, lines 65-67).

Regarding claim 7, Branton et al teaches that the hybridization medium and the dissociation medium are electrically conductive aqueous solution (column 16, lines 26-27).

Regarding claim 8, Branton et al teaches that the single stranded poly dA oligonucleotides hybridizes to complementary poly dToligonucleotides to form a duplex (column 20, line 40), thus teaching first and the second nucleic acid strands are

deoxyribonucleic acids and the nitrogen-containing aromatic bases are selected from the group consisting of adenine or thymine.

Regarding claim 9, Branton et al are silent about the metal cation is selected from the group consisting of Zn^{2+} , Co^{2+} , and Ni^{2+} .

Regarding claim 10, Branton et al are silent about the metal cations are substituted for imine protons of the nitrogen-containing aromatic bases, and the nitrogen-containing aromatic bases are selected from the group consisting of thymine and guanosine.

Regarding claim 11, Branton et al teaches that one of the aromatic nitrogen-containing aromatic bases is thymine (column 20, line 39), but are silent about the metal cation is coordinated by the N3 nitrogen atom.

Regarding claim 12, Branton et al silent about at least one of the aromatic nitrogen-containing aromatic bases is guanine, having an N1 nitrogen atom (Fig. 3), but are silent about the metal cation is coordinated by the N1 nitrogen atom.

Regarding claim 13, Branton et al are silent about a process wherein the nucleic acid duplex comprises a base pair mismatch and detecting the presence or absence of divalent metal cations in base pairs of the nucleic acid by measuring the electrical conductance across the channel as the nucleic acid duplex is translocated through the channel. Branton et al are also silent about matching hydrogen bonded base pairs of the metal containing nucleic acid duplex and mismatched base pair does not interchelate a divalent cation.

Regarding claim 1, Branton et al are silent about incorporation of metal ions into nucleic acid duplex so that metal ion is permitted to enter the duplex a metal containing base pair is formed and if a metal ion is excluded from the duplex a non-metal containing base pair is formed. Branton et al are also silent about bond formation of the metal chelation with nucleic acid.

Regarding claims 9-12, Branton et al are silent about the divalent cation being Zn^{2+} , Co^{2+} , and Ni^{2+} and coordination of metal cation with guanine and thymine bases.

Regarding claim 13, Branton et al are silent about detecting the presence or absence of divalent metal cations in the base pairs of the nucleic acid duplex and mismatched base pair does not interchelate a divalent cation.

However, incorporation of metal cations into a nucleic acid duplex and bond formation between metal ions and nucleic acids were known in the art at the time of the claimed invention was made as taught by Aich et al.

Aich et al teaches a process of forming conductive polymers comprising first and second nucleic acid strands capable of forming a nucleic acid duplex and incorporation of a metal ion into a nucleic acid duplex as the duplex forms in the hybridization medium (Fig. 1, and pg. 5, lines 16-25, pg. 8, lines 9-18). Aich et al further teaches that if a metal ion is permitted to enter the duplex and a metal containing base pair is formed and if a metal ion is excluded from the duplex a non-metal containing base pair is formed as in B-DNA (Figs. 2 and 4, and pg. 6, lines 14-25).

Aich et al also teaches that the first and the second nucleic acid strands comprise a plurality of nitrogen-containing aromatic bases covalently linked by a backbone, the nitrogen-containing aromatic bases of the first nucleic acid strand being capable of being joined by hydrogen bonding in the hybridization medium to the nitrogen-containing aromatic bases of the second nucleic acid strand so that the nitrogen-containing aromatic bases on the first and the second nucleic acid strands form hydrogen-bonded base pairs in stacked arrangement in the nucleic acid duplex, the hydrogen-bonded base pairs being capable of interchelating the metal cation coordinated to a nitrogen atom in one of the aromatic nitrogen-containing aromatic bases to form the metal-containing nucleic acid duplex (pg. 22, lines 2-13, Aich et al refers to metal containing nucleic acids as M-DNA).

Regarding claims 9 and 10, Aich et al teaches that the divalent metal cations consisting of Zn^{2+} , Co^{2+} , and Ni^{2+} ions (Aich et al claim 10) and further teaches that the metal cations are substituted for imine protons of the nitrogen-containing aromatic bases, and the nitrogen-containing aromatic bases are selected from the group consisting of thymine and guanosine (Aich et al claim 11).

Regarding claim 11, Aich et al teaches that at least one of the aromatic nitrogen-containing aromatic bases is thymine, having an N3 nitrogen atom, and the divalent metal cation is coordinated by the N3 nitrogen atom (Aich et al claim 12).

Regarding claim 12, Aich et al teaches that at least one of the aromatic nitrogen-containing aromatic bases is thymine, having an N3 nitrogen atom, and the divalent metal cation is coordinated by the N3 nitrogen atom (Aich et al claim 13).

Regarding claim 13, Aich et al teaches a method of detecting mutation comprising nucleic acid duplex having a base pair mismatch further comprising detecting the presence or absence of divalent cation in the base pair of the nucleic acid duplex (Fig. 6, pg. 11, lines 5-21). Aich et al also teaches that the matching hydrogen-bonded base pairs of the metal-containing nucleic acid duplex comprise an interchelated divalent metal cation coordinated to a nitrogen atom in one of the aromatic nitrogen-containing aromatic bases, and wherein a mismatched base pair does not interchelate a divalent cation (Fig. 2 – See the hydrogen bond formation with Zn^{2+} , Fig. 6- Last left panel -see divalent metal cation chelation with matching base pair, Last right panel-see mismatched base pair does not interchelate with divalent metal ion). Aich et al teaches that for intercalation of divalent cation hydrogen bond formation is necessary between complementary base pairs. In case of mismatched base pair such hydrogen bond formation is dramatically reduced as evidenced by Li et al (PNAS, 1991, 88, 26-30). Li et al teaches that in G:A mismatch pair has only two hydrogen bonds rather than the three hydrogen bonds in the G:C matched pair resulting in duplex instability (Li et al, Fig. 1, Abstract). It is noted that reduction in hydrogen bond formation between mismatched base pair taught by Li et al is used to further support known fact in the art.

Aich et al explicitly teaches that the “conditions for metal ion incorporation in to nucleic acid duplex varies from depending on the metal ions and nature of the nucleic acids and optimization conditions are performed through routine experimentation by varying the parameters (pg. 8, lines 9-18). Thus, combined teachings of Branton et al and Aich et al would provide a process of recording sequence information in a nucleic

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acid polymer comprising first and second nucleic acids as well as incorporating metal ions as nucleic acid duplex forms in the channel and further recording information as the metal containing duplex translocating through the channel as recited in the instant claim 1.

Aich et al also teaches that formation of metal chelated DNA is sequence specific and allows simultaneous detection of a plurality of sequences yielding abundance of recording information in short time without the necessity of time consuming steps (pg. 11, lines 25-29).

It would have been prima facie obvious to one having the ordinary skill in the art at the time the invention was made to modify the recording information method of Branton et al with the method of metal incorporation into nucleic acid duplex of Aich et al with a reasonable expectation of success.

An artisan would have been motivated to modify the sequence recording information method of Branton et al with the method of metal incorporation into nucleic acid duplex of Aich et al with the expected benefit of having a sequence specific metal chelation into nucleic acid duplex allowing simultaneous detection of a plurality of sequences yielding abundance of recording information in short time without the necessity of time consuming steps as taught by Aich et al (pg. 11, lines 25-29).

8. Claims 1 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Branton et al (USPN 6,627,067 filed Jun. 22, 2000) and Aich et al (WO 99/31115,

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published June 24, 1999) as applied to claim 1 above further in view of Anazawa et al (USPN 6,136, 543 issued Oct. 24, 2000).

Claim 4 is dependent on claim 1. Teachings of Branton et al and Aich et al regarding claim 1 are described previously in this office action in section 7.

Regarding claim 4, Branton et al teaches translocation of the nucleic acid duplex through the channel by applying voltage gradient (Fig. 12B and column 20, lines 37-67 and column 21, lines 1-15). Branton et al and Aich et al are silent about nucleic acid duplex attached to magnetic bead. However attachment of nucleic acids to magnetic bead and movement across the pore using magnetic field were known in the art at the time of claimed invention was made as taught by Anazawa et al, who teaches coupling of nucleic acids to a magnetic bead and stretching the DNA duplex using magnetic force in a channel (Fig. 9, magnetic bead # 6, DNA # 7, Abstract and column 8, lines 1-28), thus providing nucleic acid duplex coupled to a magnetic bead and translocation of DNA using magnetic field across the channel.

Thus, as described above, all of the component steps, i.e., coupling of nucleic acid duplex to magnetic bead, modulating the translocation of the DNA duplex in the channel recited in the instantly claimed invention were known in references of Branton et al, Aich et al and Anazawa et al. The only difference is the combination of known method steps of the prior art into a single method to include all the steps, which would be equivalent to a translocation of the nucleic acid duplex through the channel mediated by magnetic field across the channel.

Thus it would have been prima facie obvious to one having ordinary skill in the art to apply the coupling of nucleic acids to magnetic bead and magnetic force taught by Anazawa et al to the translocation of the duplex DNA through the nanopore by the method of Branton et al and Aich et al with the expected benefit of achieving a translocation of DNA using magnetic force.

Response to remarks from the Applicants

Claim Rejections under 35 U.S.C. § 103(a)

9. Applicant's arguments with respect to claims 1-13 have been considered but are moot in view of the new grounds of rejection necessitated by claim amendments (Remarks, pg. 6)

Furthermore, Applicant's argument with respect to teachings of Aich et al and Anazawa et al are not persuasive because Applicant has not traversed the teachings, suggestions or motivation of Aich et al and Anazawa et al.

Conclusion

10. No claims are allowed.

11. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Narayan K. Bhat whose telephone number is (571)-272-5540. The examiner can normally be reached on 8.30 am to 5 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ram R. Shukla can be reached on (571)-272-0735. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Narayan K. Bhat/

Examiner, Art Unit 1634

Narayan K. Bhat, Ph. D.

/Jehanne S Sitton/

Primary Examiner, Art Unit 1634